The Effectiveness of Riparian Buffer Zones for Protecting Waterways during Harvest in the Pipiwai Forest in Northland, New Zealand

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Abstract

The harvest of plantation forests has the potential to cause significant negative impacts on the waterways that flow through them. It has been proposed that to mitigate any such impacts waterways should be protected by undisturbed riparian buffer zones (RBZ). As such, this research has been conducted to investigate if RBZs protect plantation waterways during harvest. To do this a case study was carried out in the Pipiwai forest, one of Carter Holt Harvey Forests (CHHF) Northland plantations. In the investigation, 15 first order streams were sampled using an extended version of NIWA's stream health monitoring and assessment kit (SHMAK). The samples were taken from three different stream treatments, those harvested with undisturbed buffers, harvested with no buffers (clearcut) and standing mature pine forest. Each site had the quality of its aquatic and riparian habitats and invertebrate communities assessed via the SHMAK, which presented a rating for each streams health. Statistical analysis was also carried out to determine if any differences in the results were significant or simply an expression of the variation that could be expected in a single population. The management of the plantation was also investigated. CHHF managers were interviewed to determine the activities that could have impacted on the forest's waterways.

The results showed that clearcut streams had degraded riparian and aquatic habitats through the loss of vegetation, exposed and eroding soil, and increased streambed sedimentation. This degradation was reflected in the invertebrate communities which were dominated by high numbers of pollutant tolerant species such as mollusks and midges. Buffered waterways, however, had no such degradation and their invertebrate communities had high numbers of pristine requiring invertebrates such as mayflies. Statistical analysis showed that the habitat and invertebrate scores of the clearcut sites were significantly lower than the buffered and pine sites, and it also showed there was no significant difference between the buffered sites and the mature pine sites.

The results also showed that the management of the Pipiwai plantation was conducted to industry and council standards, but that this was insufficient to prevent the degradation of the waterways in the clearcut catchments.

The two main conclusions of this research were that RBZs in the Pipiwai forest protected waterways from degradation during plantation harvest and maintained them in a state similar to that of standing mature pine forest, and that management practices and regulations in use at the time of harvest, though within industry and government standards, were unable to prevent waterway degradation and achieve results equal to those of the RBZs.

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Introduction

Chapter One

1.1 Overview

Timber production from plantation forests is one of New Zealand's largest industries. The wood produced is used in the manufacture of chips, pulp, paper, various types of board, as well as sawn timber, logs and poles. It uses approximately 7% of the country's land area and comprised 11.3% of its exports in 2004 earning $3.117 billion (New Zealand Forest Owners Association, 2005). It is an industry in which profit margins can at times be small and as with all export commodities, its profitability is affected by the value of New Zealand's dollar.

New Zealand's land use has been dominated by pastoral farming for many years (New Zealand Forest Owners Association, 2005), and as a result, plantation forests have largely been grown on land unsuitable for pastoral farming, land that has typically been steep with low fertility (Maclaren, 1996). Trends have changed a little over the last 10-15 years as farmers have diversified their enterprises and turned areas of farmland into plantation forest (Maclaren, 1996). The majority of plantations throughout the country are planted in *Pinus radiata*, a species originating in North America. It is the dominant species as it is fast growing, can grow well on many different soil types, and can be used in a diverse range of end products (Maclaren, 1996).

A typical forest rotation from planting to complete harvest, will take approximately 28 years. For the majority of this time the plantation will largely be left undisturbed.

Seedlings will be planted and in the first couple of years there may be some spraying carried out to eliminate weed competition, or the addition of fertilizer. Then for the next 25 to 26 years the trees will largely be left to grow with the only disturbances being thinning and possible pruning. As such, the plantation becomes part of the landscape, a constant feature to regular passersby or recreational users. However, at the completion of the rotation when the trees are harvested, drastic changes are made to the physical and visual environment. Seventy percent of the environmental disturbance that occurs through the entire rotation can take place at that time (Hicks and Harmsworth, 1989). Extensive earthworks are carried out to construct the infrastructure required to extract the timber. When this is completed the trees are then felled and removed from the site. In a matter of days large areas can be harvested, changing the landscape from green forested countryside, to a landscape of bare earth strewn with dead and dying tree debris. This not only results in drastic visual impacts, but it also causes significant disturbance to the physical environmental. In a very short period, an area that has existed under a forest cover for around 20 years (since canopy closure) is reduced to a de-vegetated open environment. This process can have significant negative impacts on the ecosystem of that area. For these reasons, plantation forestry has been a topic of much debate and one into which considerable research has been conducted.

An area that has come under particular scrutiny has been the impact that plantation activities have on waterways. In the past, practices such as large scale burning, poor infrastructure construction, and careless tree extraction, have filled waterways with nutrients, sediment and slash, and caused significant negative impacts to these habitats and the aquatic communities they supported (Rosoman, 1994). In more recent years, following passage of the Resource Management Act 1991, there has become a greater requirement to minimize the negative effects that our activities have on the environment. This requirement is not only from government sectors but pressure is also coming from environmental and community groups (Rosoman, 1994). The forestry industry has also taken its own initiatives and has been conducting research into the effects of its activities and the means by which negative impacts can be mitigated or minimised. This has

occurred to the point where some companies have developed environmental standards that lift their operating practices above those required by local government regulations.

Despite the changes that have been made to forestry practices in the last 10-20 years, there are still issues regarding the environmental sustainability of forestry practices. These include increased solar radiation inputs due to the removal or riparian vegetation, increased sediment inputs due to soil disturbance, particularly immediately adjacent to waterways, (Hicks, 1998) and the significant amounts of slash that can be deposited into waterways during harvest. To address these issues and protect waterways from degradation during harvest, the use of riparian buffer zones has been proposed (Quinn *et al,* 2004; Baillie *et al,* 2005). This would be a controversial requirement as there would be financial ramifications for forestry owners if such a practice was employed. On this basis, there is a need for sound and independent research to be carried out in order to provide reliable data on the effects of plantation forestry practices and the most efficient means of addressing any negative impacts.

1.2 Research Problem

There has been considerable controversy over the environmental effects of plantation forestry and the sustainability of the industry within New Zealand (Rosoman, 1994; Maclaren, 1996). It has been both accused of causing significant environmental degradation and used as a method of environmental protection. With the passage of the Resource Management Act in 1991 there came a requirement to identify, and minimise or mitigate, any negative environmental effects of land use activities. As such, plantation forestry came under this new legislation. Combined with this Government initiative, the forestry industry has carried out significant amounts of research into its environmental effects and the means of mitigating them. One focus of both agencies has been the effects on waterways and water resources. As a result, forestry management has undergone many improvements in its practices over the last 15-20 years. Despite this,

there is still little doubt that aspects of forestry management cause at least short-term and possibly long-term waterway degradation.

To protect waterways from the impacts of forestry activities, particularly plantation harvest, it has been proposed that undisturbed native riparian buffer zones be compulsory for all plantation waterways. This is a controversial proposal as the impacts of plantation harvest may only be experienced in the short term, while the ramifications of buffer zone inclusion last for the long term. Such a requirement would impact negatively on the profits of forestry owners, on the efficiency of plantation harvest, and possibly on the environment. Furthermore, there have been few specific investigations into the effectiveness of riparian buffer zones at protecting plantation waterways, and the knowledge that is available is largely theoretical.

1.3 Aim

The aim of this study is to determine the effectiveness of riparian buffer zones at protecting the waterways in the Pipiwai forest from the impacts of plantation harvest and the implications this has for forest management.

1.4 Research Questions and Objectives

In order to achieve the above aim three research questions were proposed.

1. How has tree harvest impacted waterways with and without riparian buffer zones?

2. Has the quality of the buffered waterways been maintained at a significantly higher level than that of the clearcut waterways?

3. What implications do the answers to questions one and two have for plantation management?

In order to answer these questions, the following objectives were set:

1. Determine the quality of the invertebrates within the waterways under different plantation management regimes.
2. Determine physical water quality of the waterways under different plantation management regimes under different plantation management regimes.
3. Determine the quality of the waterway aquatic habitats under different plantation management regimes.
4. Determine the quality of the riparian habitats under different plantation management regimes.
5. Determine if there are significant differences in the stream ecosystem quality under the three management regimes.
6. Identify any management practices related to the plantation harvest that contributed to any waterway degradation or waterway protection.

1.5 Research Approach

Currently there is much interest in protecting waterways from degradation caused by various land use practices, with forestry being one of these. A measure highlighted as a means of achieving this has been the use of riparian buffer zones (RBZ). Such a move is controversial as it significantly impacts on forestry owners. As such, research is needed to determine the specific waterway impacts caused by plantation harvest and whether there are definite benefits produced by utilising RBZ. To this point there is a limited amount of data available in this area and knowledge is largely based on theory. This research therefore, will contribute more specific data on the effectiveness of riparian

buffer zones at protecting waterways during plantation harvest, and help to build an accurate understanding of sustainable plantation management.

To obtain data for this research, waterways within the Pipiwai forest that were both clearcut and buffered, as well as running through standing mature plantation, were sampled using an extended version of the Stream Health Monitoring and Assessment Kit (SHMAK) developed by the National Institute of Water and Atmosphere (NIWA) and Landcare Research. Analyses of the results from the SHMAK were used to determine how effective buffer zones were at protecting waterways from the impacts of plantation harvest.

1.6 Thesis Layout

Following this introductory first chapter, chapter two presents a review of the literature relevant to plantation forestry including: the theory of sustainability, plantation forestry activities, local government regulations and industry operating standards. Chapter three presents the background to the research, including information regarding plantation forestry in Northland, the history, geology and climate of the Pipiwai plantation and an overview of the management regime employed by Carter Holt Harvey Forests (CHHF) for the plantation. Chapter four presents the methodology of the research, including its assumptions and limitations. Chapter five presents the results of the research, which are discussed in chapter six. The final chapter presents the conclusions and recommendations of this research, including recommendations for further research.